I. Kapshar, A.G. Kovaleva
Ural Federal University named after the first President of Russia B.N. Yeltsin
Yekaterinburg, Russia

ANALYSIS OF METHODS OF QUALITY CONTROL OF RADIO ENGINEERING CIRCUITS

Abstract: Currently, there are three main types of switches in radio engineering circuits: mechanical, electric and electromagnetic. Each one of them has its own application area and its own advantages and disadvantages. But every kind of them should be checked before going into production. Production of poor-quality products can badly affect the status and reputation of a company or even worse may be harmful to the health of a human. So that's why quality control is a very important stage in the development and output of radio engineering products.

Key words: radio engineering circuit, mechanical switch, electric switch and electromagnetic switch, methods of control.

Currently, there are three main types of switches in radio engineering circuits: mechanical, electric and electromagnetic. Each one of them has its own application area and its own advantages and disadvantages. But every kind of them should be checked before going into production. Production of poor-quality products can badly affect the status and reputation of a company or even worse may be harmful to the health of a human. So that's why quality control is a very important stage in the development and output of radio engineering products.

Different methods of quality control are used in the production to provide output that meets the requirements of the market. The following types of quality control at various stages of production are essential [2]:

1. Visual inspection;
2. Electrical testing;
3. Optical control;
4. X-ray control;
5. Destroying control methods (mechanical static and dynamic);
6. Thermal nondestructive testing.

Appearance control of the products is used to assess the quality of individual process operations and as a part of the final control. The degree of accordance to the standards is essential during visual inspection. The consequence of such control is subjective, of low credibility, which does not exceed 60-65%, in addition, it requires a costly, tedious, monotonous and hard work [4].

In-circuit test - technology checks the individual components on the PCB, or fragments circuits using special equipment (ICT-stations) and equipment (needle adapter).This testing method can analyze separate components of the circuits and can be successfully applied to large-scale production.

Conventionally, in-circuit testing can be divided into analog and digital. The constant miniaturization of components leads to the reduction of the pads size. This leads to the need to withdraw pads for ICT-adapter on one side of the board, which in turn causes an increase in its size and making them difficult to trace, and often, in the case of high tires, it is impossible in principle. One of the solutions to these problems is to use a testing method "flying probes" or "flying matrix". This approach allows to avoid special pads for testing, but significantly increases the inspection, which is a significant constraint to production [6].

One more important method of quality control is a method of thermal nondestructive quality control. The first task in developing this method of thermal nondestructive quality control is to prepare a visual image.

This task includes the following steps: filtering and normalization (scaling and rotation).

The second task is to prepare termograms: selection of reference points and normalization (scaling and rotation).

Image filtering SUSAN

The use of SUSAN method helps in cleaning different types of image noise. This method involves two stages.

Initially determined by the "noise" pixel (usually in the detection of noise is the main difficulty). Then the noise pixel value is replaced by new, usually calculated from surrounding pixels values. Usually when using SUSAN treated group pixels 5 × 5 elements, the central pixel of this matrix is the subject testing. Developing an automated method for quality control of processed pixel group has been reduced to 3 × 3 as when working with small elements should be possible to accurately filter out noise. Using a pixel matrix 3 × 3 slows down some applications, but shows

more accurate results required for the next stage of selection outlines elements. Criterion noise in this method is to consider n pixels, trapped in a matrix of pixels. After detecting a noise pixel it is necessary to replace the mean value (counting values, taking into account all points except the noise).

There is a thermal imager - device for infrared imaging. This device provides visualization of temperature fields available on the surface observed. Infrared imager has many sensitive items placed on the same substrate – matrix (160x120, 320x240, 640x480). Each element generates an output signal depending on the size of SRI signal, received by the object surface unit [3].

The basis of the principle of thermal imaging devices is in transformation of the thermal radiation from objects [4]. Having in view the recorded thermal contrast allows the monitor to visualize halftone black and white image or thermal imaging. Thermal allows providing thermal image of the object with the same field of temperature isotherms. The individual brightness of the image of the object is compared with the brightness scale corresponding to the transition from white to black.

Figure 1 shows a generalized functional scheme of the scanning thermal imager.

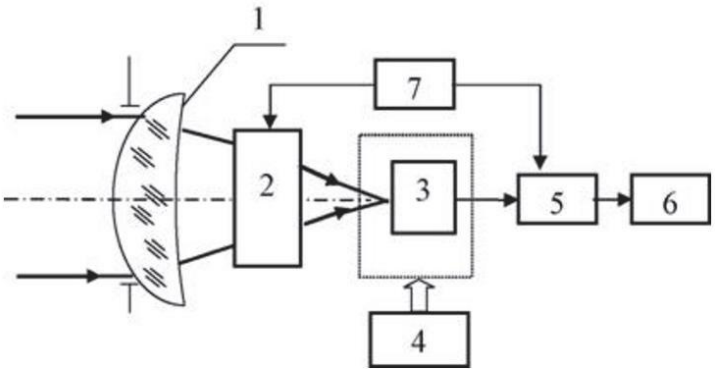

Figure 1 – Generalized functional scheme of the scanning thermal imager: 1 - optical system; 2 - optical-mechanical scanning unit; 3 - radiation receiver; 4 - cooling system; 5 - electronic path; 6 - video monitoring device; 7 - synchronization system.

There are several methods to identify the path to the visible image. Among them is Robert operator [5].

Let 3x3 region, shown in the figure below (Figure 2), be the brightness in the vicinity of a picture element.

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Figure 2 – 3x3 area in the testing image

One of the easiest ways of finding the first derivatives in the point z_5 is to use the next cross gradient operator Roberts:

$G_x=(z_9-z_5)$, (1)

$G_y=(z_8-z_6)$. (2)

These derivatives can be realized by processing the entire image by using the described masks in Figure 3, pre-filtering using the procedure described previously.

-1	0
0	1

0	-1
1	0

Figure 3 – Roberts operator masks

Implementation of size 2x2 masks isn't comfortable because they don't have explicit central element, which significantly affects the result of the filtering. But this "negative" generating is a very useful feature of this algorithm - high speed image processing [6]. The result of the operator Roberts is shown in Figure 4.

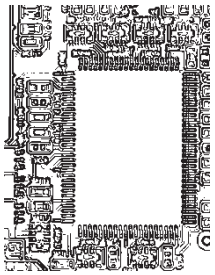

Figure 4 – Dedicated contours of objects

Edge detection on a real image and the transfer of the final circuit on a real image on the thermogram is needed on the stage of the selection of the area of interest. The second phase requires the subsequent quality control of HS. This step is realized by developing software product on the basis of the developed method. To select thermogram in areas of interest, namely the region in excess of the limit value range of operating temperatures, visible image normalization is performed by means of

reference points. This is the phase of visualization of the image of the zone of interest in the thermogram. This is followed by the transfer circuit with a visible image on termogram. The second step of the method of thermal gagging is to compare the results, such as temperature database, which stores operating temperature range of items [7].

In conclusion it is necessary to underline that developed methods help to organize an automated quality control system. The methods save considerable funds for quality control in production. On the basis of the developed methods a program that automates all steps necessary for the implementation of quality control is developed.

И. Капшарь, А.Г. Ковалева
Уральский федеральный университет имени первого Президента России Б.Н. Ельцина
Екатеринбург, Россия

АНАЛИЗ МЕТОДОВ КОНТРОЛЯ РАДИОТЕХНИЧЕСКИХ СХЕМ

Аннотация: в настоящее время существует три основных типа переключателей в радиотехнических цепях: механический, электрический и электромагнитный. Каждый из них имеет свою область применения и свои достоинства, и недостатки. Но любой переключатель должен быть проверен прежде, чем идти в производство. Производство некачественной продукции может плохо сказаться на статусе и репутации предприятия или, еще хуже, может нанести вред здоровью человека. Поэтому контроль качества является очень важным этапом в разработке и выпуске радиотехнической продукции.

Ключевые слова: радиотехническая схема, механический переключатель, электрический переключатель, электромагнитный переключатель, метод контроля.

СПИСОК ЛИТЕРАТУРЫ:

1. Andronov A.A., Vitt A.A., Haikin C.E. Oscillations theory. Moscow, Physical and mathematical literature Government Publishers, 1959.

2. Bahvalov N.S., Zhidkiv N.P., Kobelkov G.M. Numerical methods. Moscow, Base knowledge laboratory, 2002.

3. Budadin O.N., Abramova E.V., Lebedev O.V., Rodin M.A. Residential structures' and industrial building's heat-engineering charasteristics determination and nondestructive testing devices. – Building materials, devices, XXIth century technologies – #9(44), 2002.

4. Budadin O.N., Abramova E.V., Rodin M.A., Lebedev O.V., Thermal defectoscopy of buildings and building constructions. – Defectoscopy #5, 2003.

5. Budadin O.N., Potapov A.I., Kolganov V.I. and others. Thermal nondestructive testing. – Moscow, Science, 2002.

6. Pang Jihong, Xue Xiaobo, Jin Yini, Li Yongchao Research on quality evaluation and forecast control in assembly process for complex products. Journal of Physics: Conf. Series. – 2017.

7. Tihonov A.N., Samarsky A.A. Mathematical physics equations. Moscow, Science, 1977.